



# **NWS Plan for Locally-run High Resolution Modeling**

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**Briefing to  
NWS Corporate Board**

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# High Resolution Modeling Objectives



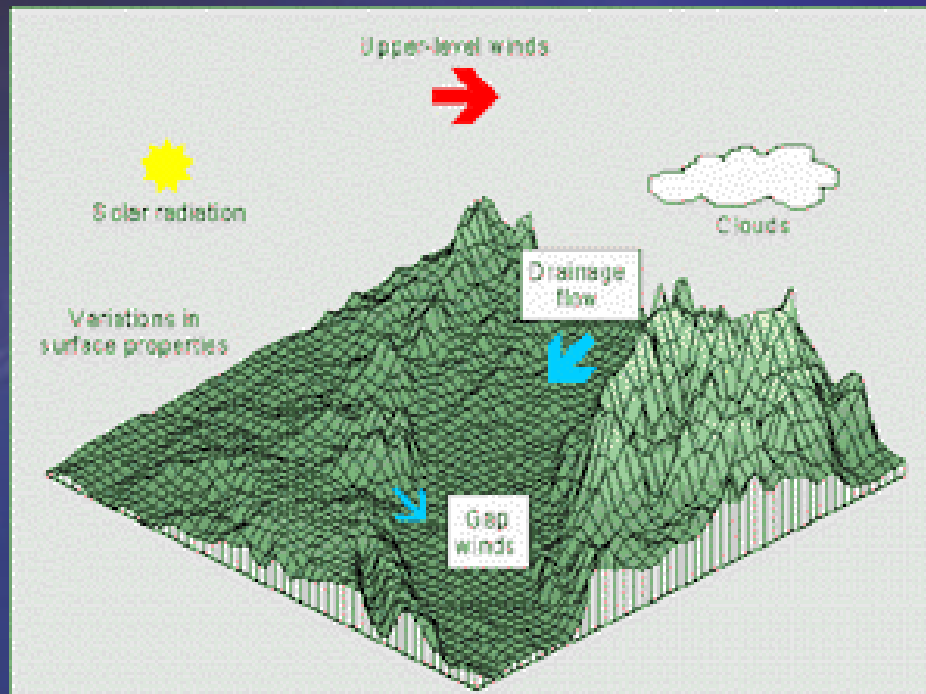
- Improving ***daily forecasts*** of sensible weather for commercial and public interests
- Improving ***preparation/response*** to weather-related events
- Improving ***river flow forecasting*** through Improved QPF
- Improving ***atmospheric constituent forecasting*** by including localized weather phenomena
- Improving ***coastal weather forecasts*** for marine activities



# Locally Run High Resolution NWP Vision



WFOs are provided L-NWP outputs at resolutions required to meet local warning and forecast goals



Example of complex terrain flow interactions



# NWS Contribution to FY03 Initiatives



## *Where? - 2 Pilot Regions*

### 1) South-East US



### 2) North West US

WA, OR, CA, ID,  
MT, UT





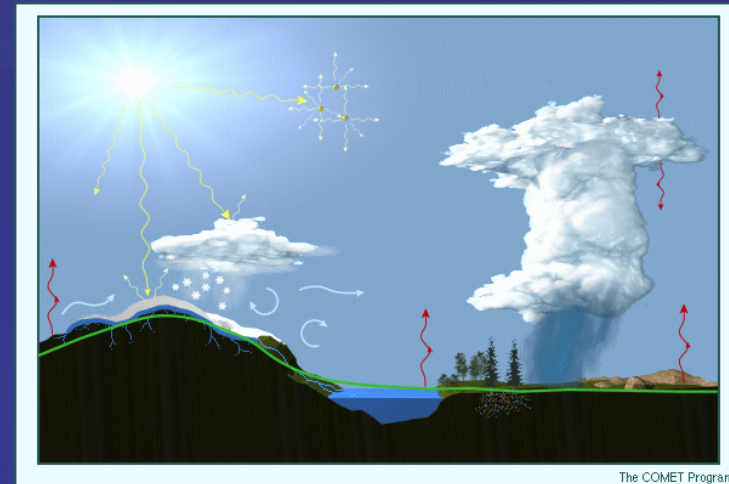


# Locally-run High Resolution NWP



## Why?

- ✓ More accurate specification (timing & location) of temperature & precipitation
- ✓ Run model on demand (0-24h @ 2 km) for:
  - *Rapidly evolving weather systems*
- ✓ Assimilate local radar & meso-net data in models:
  - Much local data already at the WFO
  - Building on research that OAR/NCEP have supported
- ✓ Training tool: Simulations of local forecast phenomena





# Locally run High-Resolution NWP

## *Expected Results*



Critical Elements	Accuracy/Lead Time			
		<i>Current Skill</i>	<i>Strategic Plan Goal</i>	<i>Initiative Contribution</i>
Temperature	Max/Min	4.6 deg	2.0 deg	3.8 (30%)
River Flow				
Flash	Occur	44 min.	58 min.	47 (20%)
Wind	Speed/Dir	0.50	0.66	0.58 (50%)
Visibility	¼ Mile	0.11	0.17	0.14 (50%)

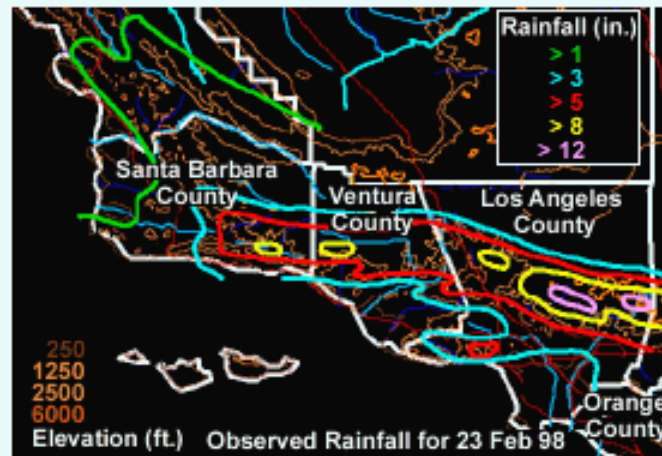
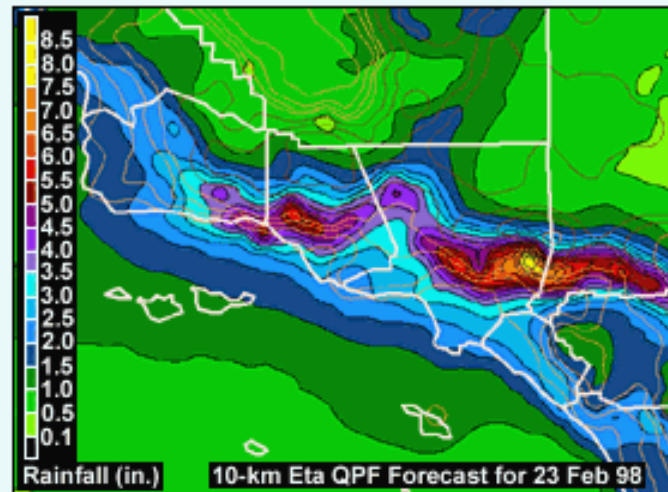
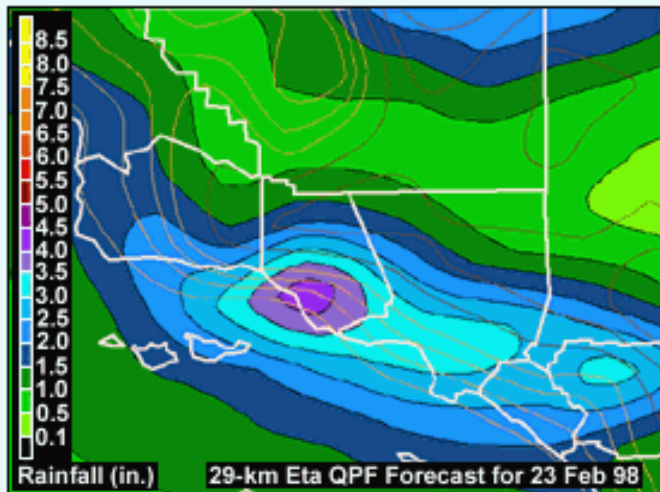


# Locally run High Res NWP



*Why run a high resolution model?*

*National vs 10 km Eta QPF*

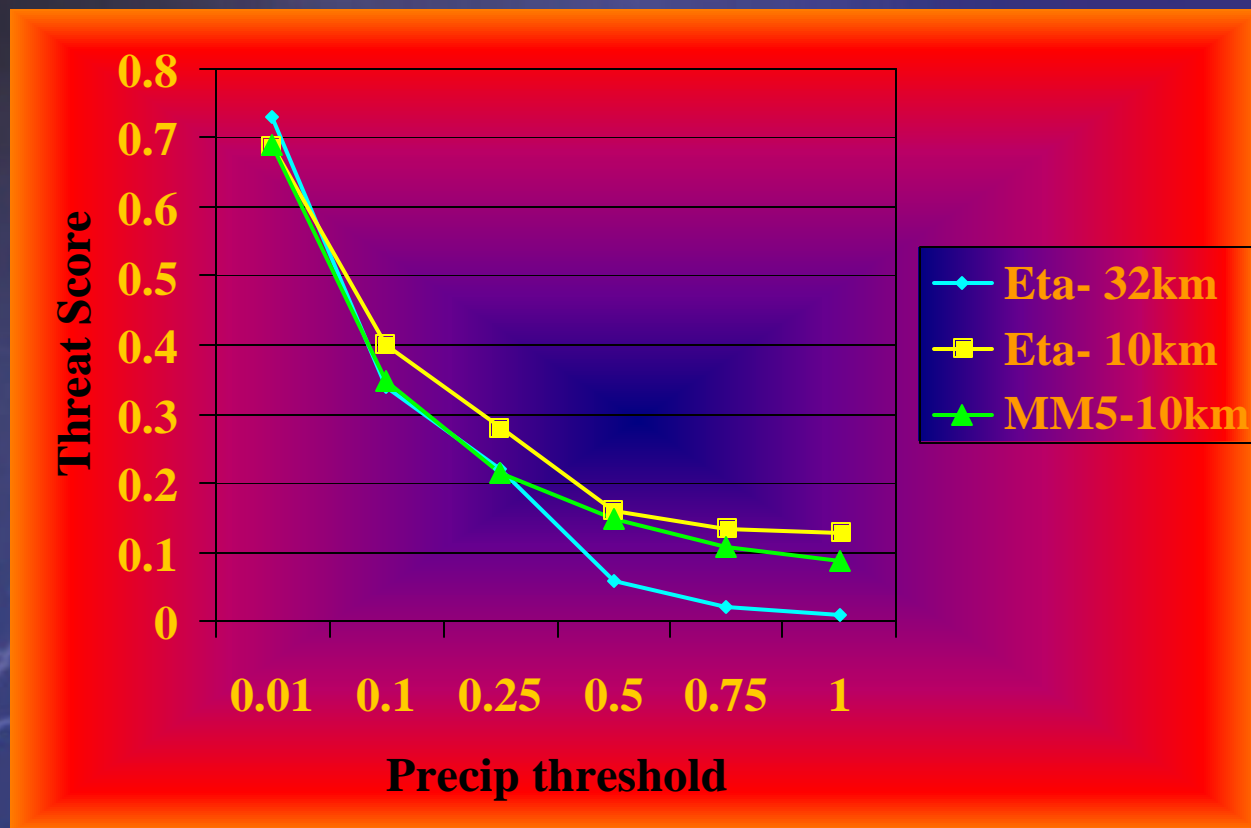




# *Why run a high-resolution model?*

*Year : 1998, 6-state domain centered on Colorado.*

*Precipitation threat scores for National Eta, Workstation Eta, MM5*







# Locally run High Res NWP

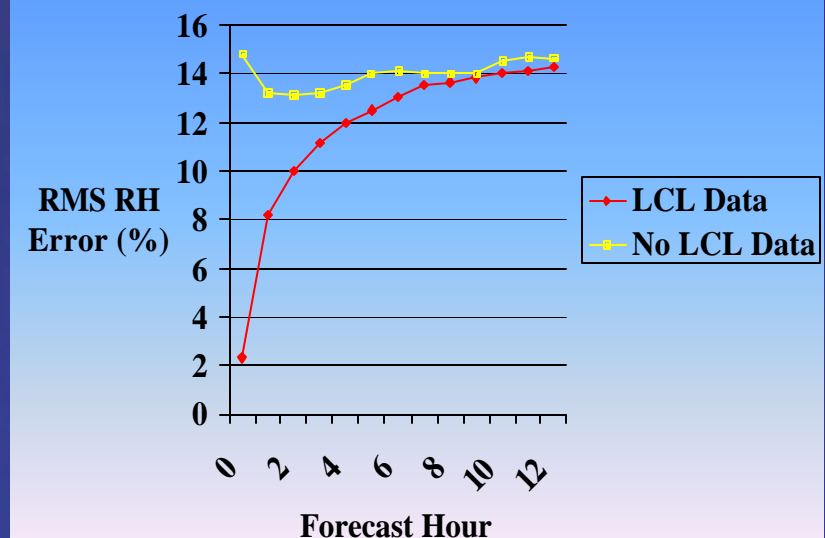
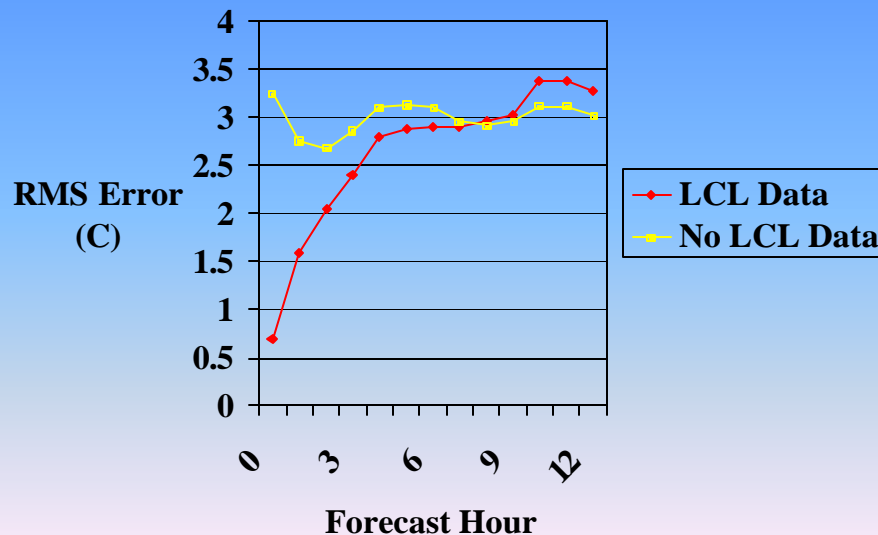


## *Why use local data?*

*Fall 2000, 11-state domain centered on Colorado.  
MM5 RMS surface errors versus Forecast Hour  
with and without local data*

Temp (C)

RH(%)





# Why run High Resolution NWP locally at WFOs ?



- ✓ Run models on demand
- ✓ Timely, high resolution output available at WFOs → at lower costs than can be done at NCEP:
  - NCEP Scenario: COMMS Upgrade: \$16 M + Gateway upgrades**
  - L-NWP Scenario: CPU Upgrade: \$5 M (135 WFOs & RFCs)**
- ✓ WFO customizations for local features
  - More appropriate parameterizations, What-if Scenarios
- ✓ More S&T partnering with universities

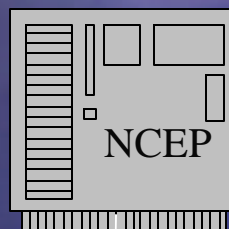


# High Res NWP @ NCEP ?

Comms: \$16 M/yr + Gateway &  
Super-computer upgrades



1200x1800 km sub-grids  
DX=2 km



8 T3 Lines  
~800 k/yr

8 T3 Lines  
~800 k/yr

8 T3 Lines  
~800 k/yr

RFC

400x400 km  
Sub-grids

RFC

RFC

5 T1 Lines  
~50 k/yr

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WFO

WFO

WFO

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WFO



# Advantages beyond NCEP models



## ✓ Ingest of full local data

- 1-2°F improvement in first 6 hrs over national model (FSL, 2001)

## ✓ Increasing resolution resulted in :

- Improvement from 0.07 to 0.15 in threat scores at precip thresholds of 0.50" or more (FSL, 2001)
- Terrain-modulated precipitation were accurately forecast (NCEP, 1999)
- 54% improvement in marine winds forecasts at 4 km resolution (OAR, 2001)







# Locally-run High Resolution NWP Use at WFOs



## *Survey Results*

### ✓ **Survey (78 respondents)**

- ***49% of WFOs use L-NWP output***
- ***22% run L-NWP models at office***
- ***44% use MM5, 36 % use WS-Eta***
- ***8% use local data assimilation***  
***or only 6 WFOs***





# Locally-run High Resolution System



## ✓ Vision

- **Location:** Eventually all WFOs & RFCs
- **Model :** *WRF*
- **Assimilation –** *WRF static initialization w/local data → 3DVAR*
- **Run times:** *24 h, 4x/day and on-demand*
- **Resolution :** *3km initially and then 4-5x NCEP national model resolution*
- **Postprocessing:** *Full AWIPS suite & IFPS ingest*
- **System:** *PC-based Linux Cluster*
- **Maintenance:** *Central support (2 person yrs)*
- **Ease of use:** *Analyze with IFPS*

*Expertise at the WFO thru training*



# Architecture



- ✓ **System Hardware** (OST: 25 k/site)
  - *PC-based, LINUX cluster 8-processor*
  - *Communications: NCEP grid resolution*
- ✓ **Forecast Techniques** (OST: 4 staff mo.)
  - *AWIPS & IFPS linkages*
- **Mesoscale Verification System** (NWS/OAR: 12 mo.)
- ✓ **Training : Web based documents** (OS: 1 staff mo.)
- ✓ **Comms : Use current infra-structure**  
**with paired-downed LBC's** (NCEP: 4 staff mo.)
- ✓ **Support : 8x5 M-F** (OS/NCEP: 1 staff yr)







# Responsibilities for FY03 NWS Actions



## ✓ NWS/WFO

- L-NWP utilization

## ✓ NWS/OCWWS

- L-NWP support

## NWS/OOS

Deploy L-NWP systems

## NWS/OST

- L-NWP – AWIPS link
- Evaluation system

## ✓ NCEP/EMC

- Adapt models for local applications
- L-NWP support

## ✓ OAR

- Develop/upgrade L-NWP
- *Develop air quality system*





# High Resolution Modeling Budget Table



	Responsible	FY03	FY04	FY05	FY06	FY07	FY08	Complete
<b>One Time Investments (\$K)</b>		<b>2</b>	<b>26</b>	<b>26</b>	<b>26</b>	<b>26</b>	<b>26</b>	<b>132</b>
Develop assimilation to incorporate local data	OAR/NCEP	120k	80k	40k	40k	40k	40k	
Develop localized WRF	NCEP/OAR	120k	80k	40k	40 k	40k	40k	
WRF testing	NCEP/OAR	60k	40k	20k	20k	20k	20k	
Create paired-down boundary data	NCEP	40k	40k	40k	40k	40k	40k	
Develop model verification	OST/NCEP/ OAR	120k	80k	40k	40k	40k	40k	
AWIPS/IFPS Integration	OST	40k	25k	15k	15k	15k	15k	
Training & config management	OS	30k	30k	30k	30k	30k	30k	
Purchase workstation(25k/site)	OOS	50k	650k	650k	650k	650k	650k	
Install assimilation & WRF (12.5k/site)	OAR/OS/WFO	25k	325k	325k	325k	325k	325k	
<b>Subtotal</b>		<b>605k</b>	<b>1,350k</b>	<b>1,200k</b>	<b>1200k</b>	<b>1200k</b>	<b>1200k</b>	
<b>Recurring O &amp; M (\$K)</b>								
Support/upgrades/maintenance	OS/NCEP	220k	220k	220k	220k	220k	220k	
<b>TOTAL</b>		<b>725k</b>	<b>1570k</b>	<b>1420k</b>	<b>1420k</b>	<b>1420k</b>	<b>1420k</b>	<b>7,975k</b>



# **Implementation Strategy**

## ***Targets of Opportunity***



- ✓ **Include L-NWP in appropriate initiatives (ala AHPS)**
  - ***Coastal Storms → Target WFOs in Pilot Areas***
  - ***Fire Weather → Target WFOs in Montana, Dakotas***
  - ***Energy → Target WFOs in Energy Critical sectors in Pac NW and Texas***
- ✓ **Vision: *All WFOs are provided L-NWP output at resolutions required to meet local warning and forecast goals***



# Milestones: Locally-run high resolution modeling



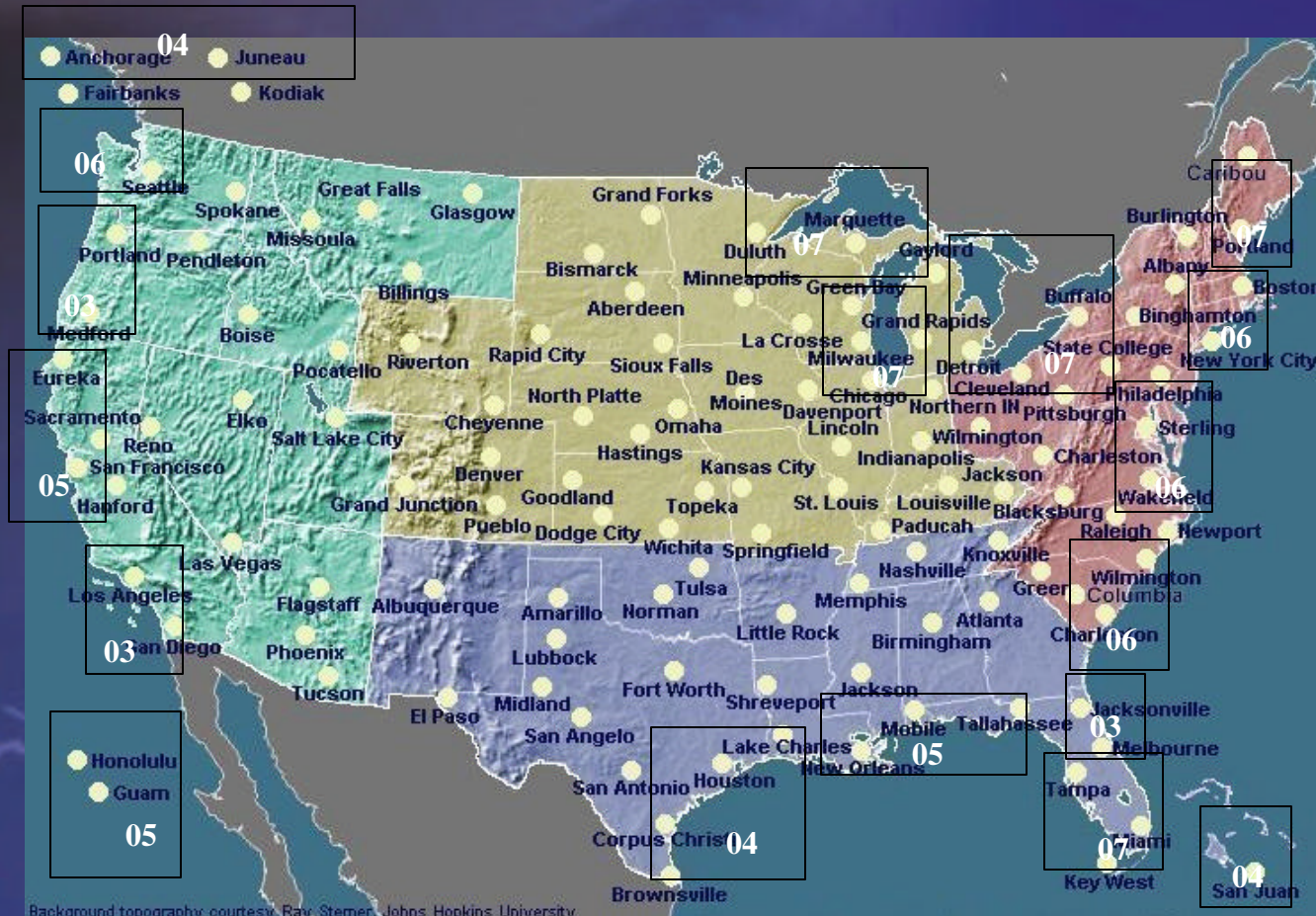
Deliverables	FY02	FY03	FY04	FY05	FY06	FY07
Local NWP Coasts	<i>Develop</i> NE FL	NE FL Pac NW S Cal	Alaska W. Gulf Puerto Rico NW	Hawaii N. Cal E. Gulf	Southeast Mid Atlantic S. New England Upper Pac NW	E. Great Lakes W. Great Lakes N. Great Lakes Maine S. Florida
Local NWP Energy (Inland)		<i>Develop</i> TX N Cal	Upper Pac NW OR TX LA	SC US	Southeast Mid Atlantic S. New England	NC US Maine





# Coastal Storms Implementation

## *Nationwide by FY 07*







# Summary



- **Local run high resolution modeling is possible now**
- **Numerous studies have shown benefits for high resolution models**
- **Advantages to running high resolution models locally:**
  - *Will optimize the use of local data*
  - *Allows for quick access to highest resolution predictions*
  - *Customizations, run on demand for rapidly evolving weather*





# BACKUP





# L-NWP Contribution to Energy Initiative

*Why?*



## ✓ Improve daily to seasonal temperature forecasts:

- *Current error in daily temperature forecasts = 4.6°F*
  - High resolution modeling can reduce error to 3.6°F
  - A 1°F improvement in 0-24 h temperature forecasts will save on the order of \$30 M/day in gas & \$10M/day electrical costs.

*(Duke Power, 1999)*

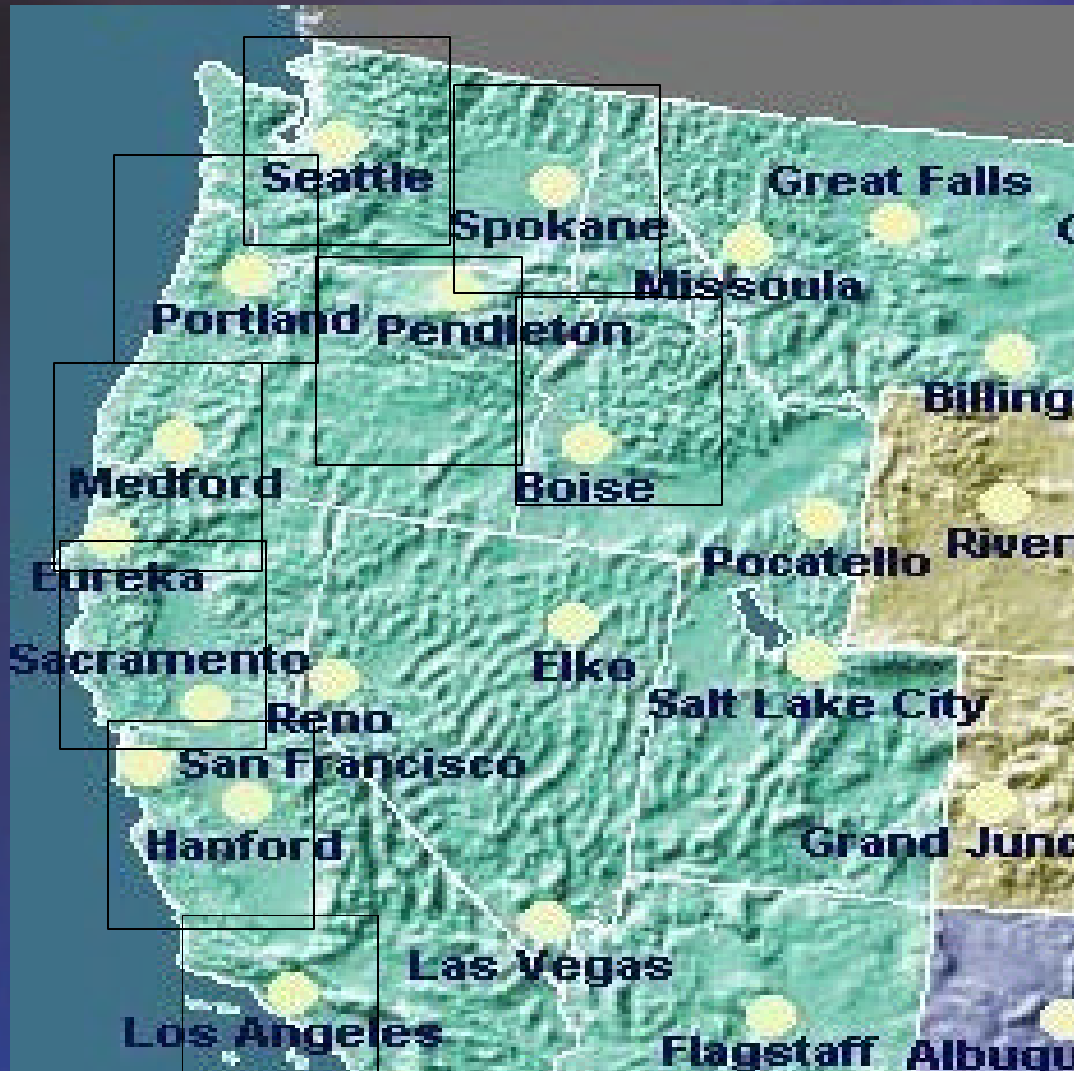
## ✓ Improve QPF for river flow forecasting to optimize power generation

- *Currently, limited probabilistic or seasonal river flow products for water flow management*
  - AHPS provides extended lead-time river flow products
  - \$2.72 M yearly savings for power production at Folsom Reservoir with AHPS (Hydrology Research Center, 1999)



# Energy Initiative

## *Where?*



### Pacific Region:

- ✓ Install L-NWP sites
- ✓ Implement AHPS
- ✓ Modernize CO-OP sites
- ✓ Deploy WVSS systems
- ✓ Improve seasonal forecasts





# Energy Initiative

*Where ?*



**South-Central US:**

- ✓ Install L-NWP sites
- ✓ Implement AHPS
- ✓ Modernize CO-OP sites
- ✓ Deploy WVSS systems
- ✓ Improve seasonal forecasts



# **Energy Initiative**

## *Expected Results, (cont.)*



### **Current Products**

- ***Wind Speed and Direction***
- ***Significant Weather***
- ***Precipitation***
- ***Visibility ( airports)***

### **New Products**

- ***High-resolution temperatures***
- ***High-resolution significant weather***
- ***QPF for River flow Forecasts***
- ***High-resolution Winds***
- ***Visibility/ water level(NOS) for fuel transport***



# L-NWP Configuration 2

## *Run Models at 13 RFCs*



### •NCEP to RFC Communications Requirement

- 100 MB file transferred in 1/2 hour*
- Transmission speed requirement: 0.44 mb/sec*

➔ *No upgrades*

### •RFC to WFO Communications Requirement

- 750 MB file transferred in 1/2 hour
- Transmission speed requirement: 3.3 mb/sec

➔ *600 T1 Lines + upgraded WAN routers ~\$6.0 M/yr +upgrades*



# L-NWP Configuration 3

## *Run Models at 121 WFOs*



- **NCEP to RFC Communications Requirement**

- *100 MB file transferred in 1/2 hour*
- *Transmission speed requirement: 0.44 mb/sec*

- **RFC to WFO Communications Requirement**

- *100 MB file transferred in 1/2 hour*
- *Transmission speed requirement: 0.44 mb/sec*

➔ *No upgrades*